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Range expansion of two box jellyfish (Cnidaria, Cubozoa) in southern Gulf of Mexico

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Abstract

We report range extensions of *Chiropsalmus quadrumanus* (Müller, 1859) and *Tripedalia cystophora* Conant, 1897 to 2 coastal lagoons in the southern Gulf of Mexico. These new records are the first for these species in Yucatán and Mexico.

Key words

Coastal lagoon, medusae, new records, Yucatán.

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Introduction

The class Cubozoa (subphylum Medusozoa; Bentlage et al. 2009) contains 2 orders, Carybdeida and Chirodropida, which together have 61 valid species (Collins and Jarms 2019). Cubozoans occur in tropical and subtropical zones around the world (Stewart 1996). They are exclusively marine and currently are of great scientific interest because they are considered dangerous species (Bentlage and Lewis 2012, Cedeño-Posso and Lecompte 2013).

There are 6 species of cubozoans reported for the Gulf of Mexico: *Tripedalia cystophora* Conant, 1897, *Tamoya haplonema* Müller, 1859, *Alatina alata* (Reynaud, 1830) *Alatina grandis* (Agassiz & Mayer, 1902), *Carybdea marsupialis* (Linnaeus, 1758), and *Chiropsalmus quadrumanus* (Müller, 1859) (Segura-Puertas et al. 2009, Lasley et al. 2016). Their occurrence in coastal lagoons in the south part of the Gulf of Mexico is poorly documented. Of the 3 species recorded for the southwest Gulf, *T. haplonema*, *C. marsupialis*, and *C. quadrumanus*, only the last species has been found in a coastal lagoon (Flores-Galicia and De la Cruz-Francisco 2018).

Tripedalia cystophora and *Chiropsalmus quadrumanus* are 2 of the most frequently studied species (Lasley et al. 2016). They have been used as a model in ecological and neurobiological investigations, which focus on the advanced sensory complexes, compound eyes, and high toxicity of these species (Stewart 1996, Coates 2003, Gershwin 2006, Garm et al. 2007).

Chiropsalmus quadrumanus, was first described in Brazil (Müller 1859) and has since been recorded

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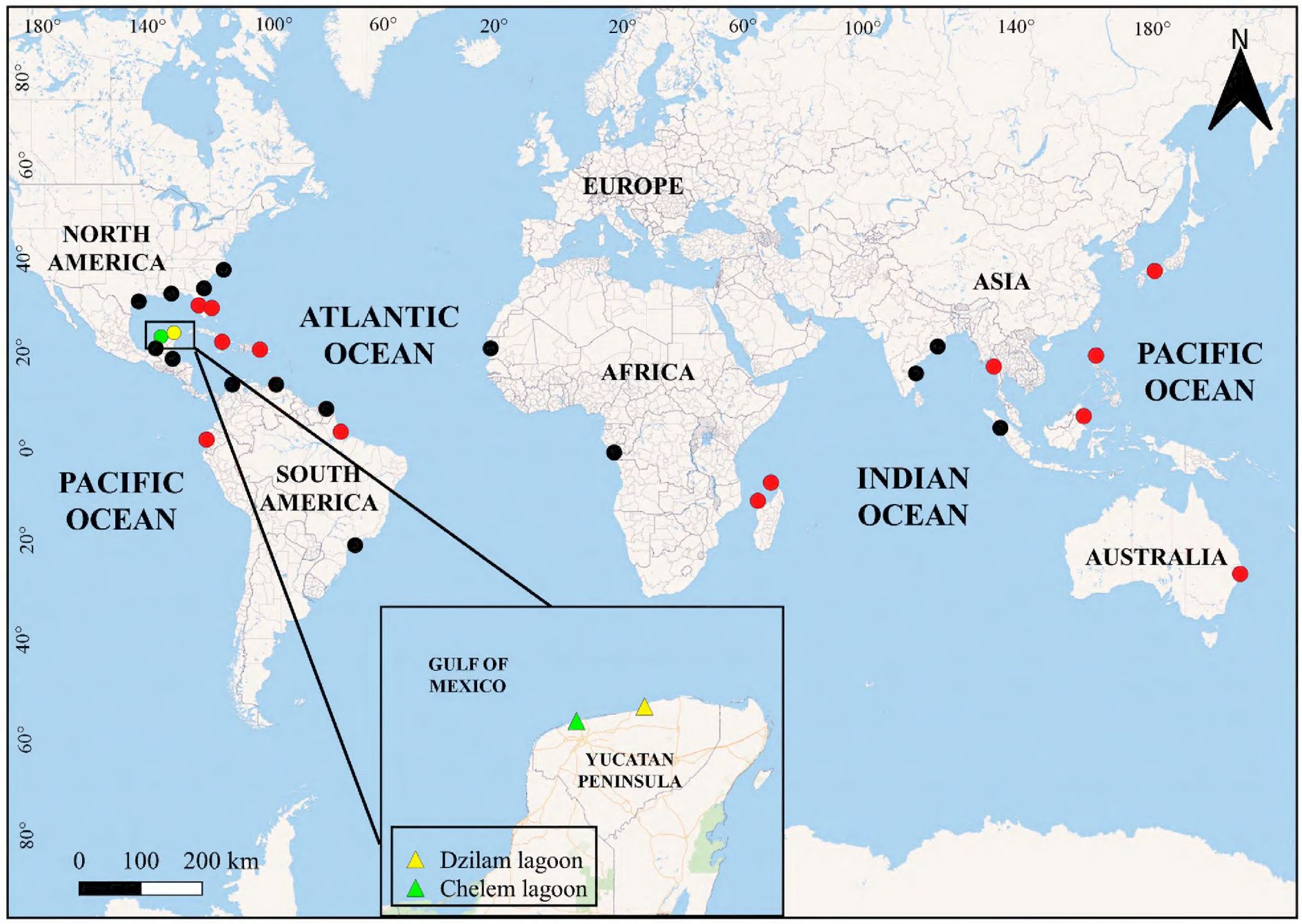

Figure 1. Worldwide distribution map of *Tripedalia cystophora* Conant, 1897 and *Chiropsalmus quadrumanus* (Müller, 1859). Previous records: red dots = *T. cystophora*; black dots = *C. quadrumanus* (Gershwin 2006, Ekins and Gershwin 2014). New records: green dot = *C. quadrumanus* in Chelem; yellow dot = *T. cystophora* in Dzilam.

from 3 states of the USA in the northern Gulf of Mexico, i.e., Texas (Guest 1959), Mississippi (Phillips and Burke 1970), and in Georgia (Kraeuter and Setzler 1975) and in the southwest Gulf of Mexico from the state of Campeche (Gómez-Aguirre 1986). This jellyfish also has been reported in Belize (Larson 1982) and Colombia (Cedeño-Posso and Lecompte 2013). Elsewhere in the world *Chiropsalmus quadrumanus* has been recorded from the Madras and Puri coasts (India), Sumatra (Indonesia), Pointe Nore, Moita Seca, and Banana Island i(West Africa), and Margarita Island i(Venezuela) (Gershwin 2006) (Fig. 1).

Since the first description of *T. cystophora* in Jamaica (Conant 1897), this species has been reported in several localities around the world. Records from the Atlantic Ocean include Brazil (Migotto et al. 2002), Jamaica and Puerto Rico (Coates 2003), and Florida (Orellana and Collins 2011). It was reported for the first time in the Gulf of Mexico by Lasley et al. (2016) near Bonita Springs, Florida. It has also been reported from the Pacific Ocean: Japan (Uchida 1970), Costa Rica (Rodríguez-Sáenz and Segura-Puertas 2009), Australia, Thailand, Indonesia (Ekins and Gershwin 2014), and Hawaii (Crow et al. 2015), and from the Indian Ocean, from Aldabra Atoll (Ekins and Gershwin 2014, Lasley et al. 2016). We document new records of *T. cystophora* and *C. quadrumanus* from the southern Gulf of Mexico. These represent the first record of both species for Mexican waters and the state of Yucatán.

Methods

The coastal lagoons of Dzilam de Bravo and Chelem are in northern Yucatán state, Mexico. Dzilam lagoon, within the state reserve of Dzilam, is surrounded by mangrove forest principally composed of *Rhizophora mangle* (Linnaeus, 1753) and *Laguncularia racemosa* (Linnaeus) CF Gaertner, 1807. The lagoon is connected to the sea by an inlet in its central part and salinity levels are generally estuarine. The principal seagrasses that cover the bottom are *Halodule wrightii* Ascherson, 1868, *Thalassia testudinum* (Banks ex Köning, 1805), *Syringodium filiforme* Kützing, 1860, and *Ruppia maritima* (Linnaeus, 1753).

In contrast, the lagoon of Chelem is between the port of Progreso and the town of Chelem. It is surrounded by *R. mangle* and is one of the lagoons most affected by urban growth. The lagoon is usually euhaline, connected to the sea by an artificial inlet, and is covered principally *by H. wrightii* and *T. testudinum* (Herrera-Silveira and Morales-Ojeda 2010).

Chiropsalmus quadrumanus (Müller, 1859) and *Tripedalia cystophora* Conant, 1897 were found in separate lagoons, either by surface trawls of 5 minutes dura-

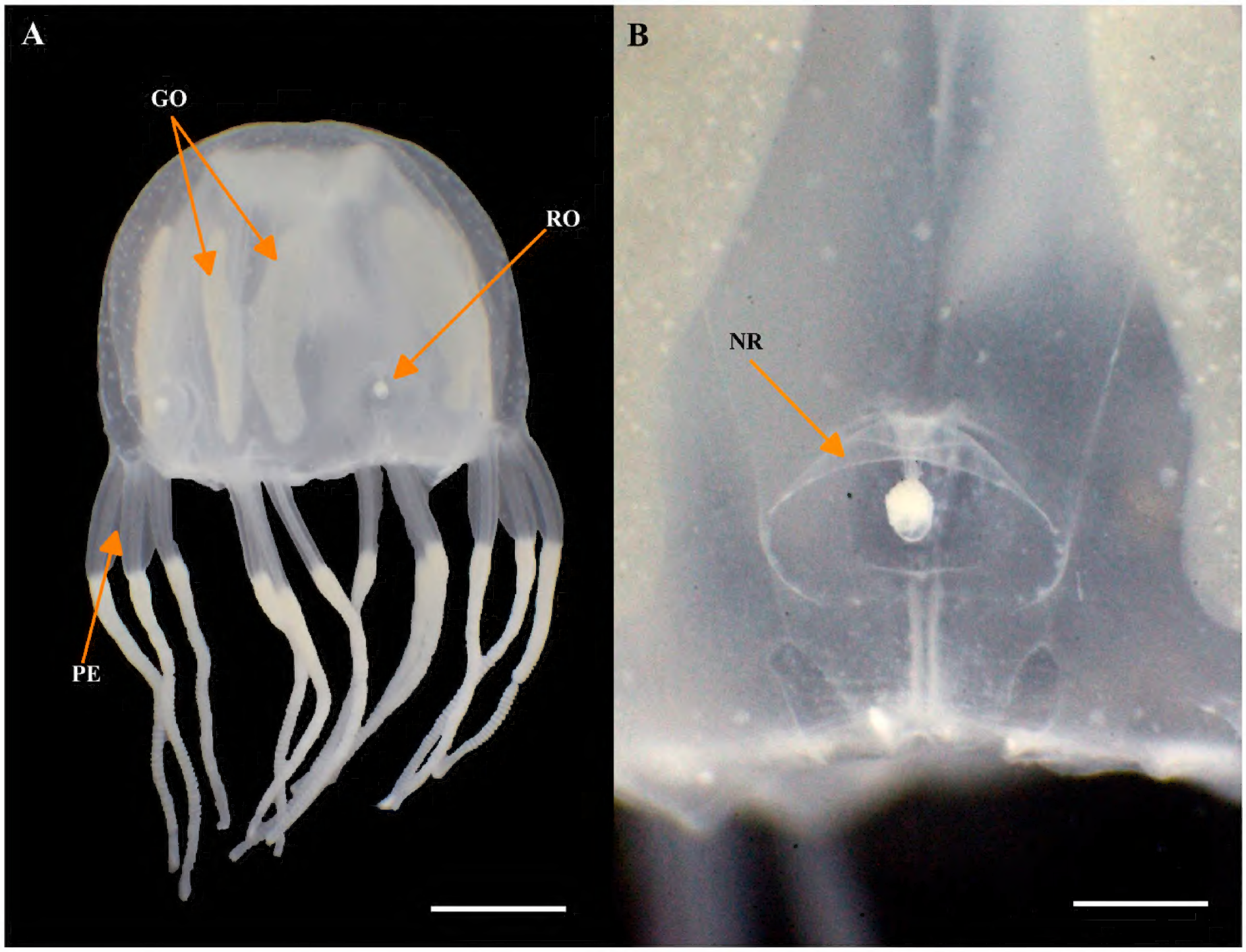

Figure 2. *Tripedalia cystophora* Conant, 1897. **A.** Paired gonads (GO), the rhopalia (RO), and the 3 pedalia per side (PE). **B.** Frown-shaped rhopaliar niche ostium (NR). Scale bars: A = 6 mm, B = 1 mm.

tion with a zooplankton net of 60 cm in diameter and 333 µm of clear mesh in 6 stations of the Dzilam de Bravo lagoon (*T. cystophora*), or with a hand net of 25 cm in diameter and 2 cm of clear mesh in Chelem lagoon (*C. quadrumanus*). All samples were fixed in 4% formalin solution and neutralized with sodium borate. The jellyfish were identified according to Gershwin (2006) and Bentlage and Lewis (2012) using morphological features (Table 1) and deposited in the Colección zoológica de invertebrados, Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Yucatán (UADY-YUC-CC), and the Cnidarian's Collection from the Gulf of Mexico and the Caribbean Sea, Universidad Nacional Autónoma de México (YUC-CC).

Results

Tripedalia cystophora Conant, 1897

Figure 2

Materials examined. Mexico. Yucatan, Dzilam de Bravo (21°19′N, 089°58′W), Lorena León Deniz leg., 1.5 m depth, May 2012 (1 specimen, UADY-YUC-CC-250-11-19373).

Identification. Observed features of the collected specimens: cube-shaped bell with 3 pedalia in each of the corners; pedalia length 1/2 to 2/3 height of bell; bell slightly higher than wide, flattened apically in a side view; exumbrella sparsely covered with small warts of nematocysts; small and flat stomach, connected with 4 gastric

Table 1. Comparison of the average morphometric measurements of *Chiropsalmus quadrumanus* and *Tripedalia cystophora* with other records (minimum and maximum values).

	C. quadrumanus (Müller, 1859)	Gershwin (2006)	*T. cystophora* Conant, 1897	Ekins and Gershwin (2014)
Bell length (mm)	27.5 (19–33)	100	8.6 (7–11)	10.9
Bell width (mm)	28.8 (16–38)	120	10.3 (8–13)	12.8
Inter rhopaliar distance (mm)	14.3 (8–19)	—	4.6 (4–5)	—
Pedalia width (mm)	7.9 (5–11)	—	2.3 (2–3)	—
Pedalia length (mm)	15 (11–18)	—	4.1 (3.5–5)	—
No. Tentacles per pedalia	6–7	Up to 7–9	1	1

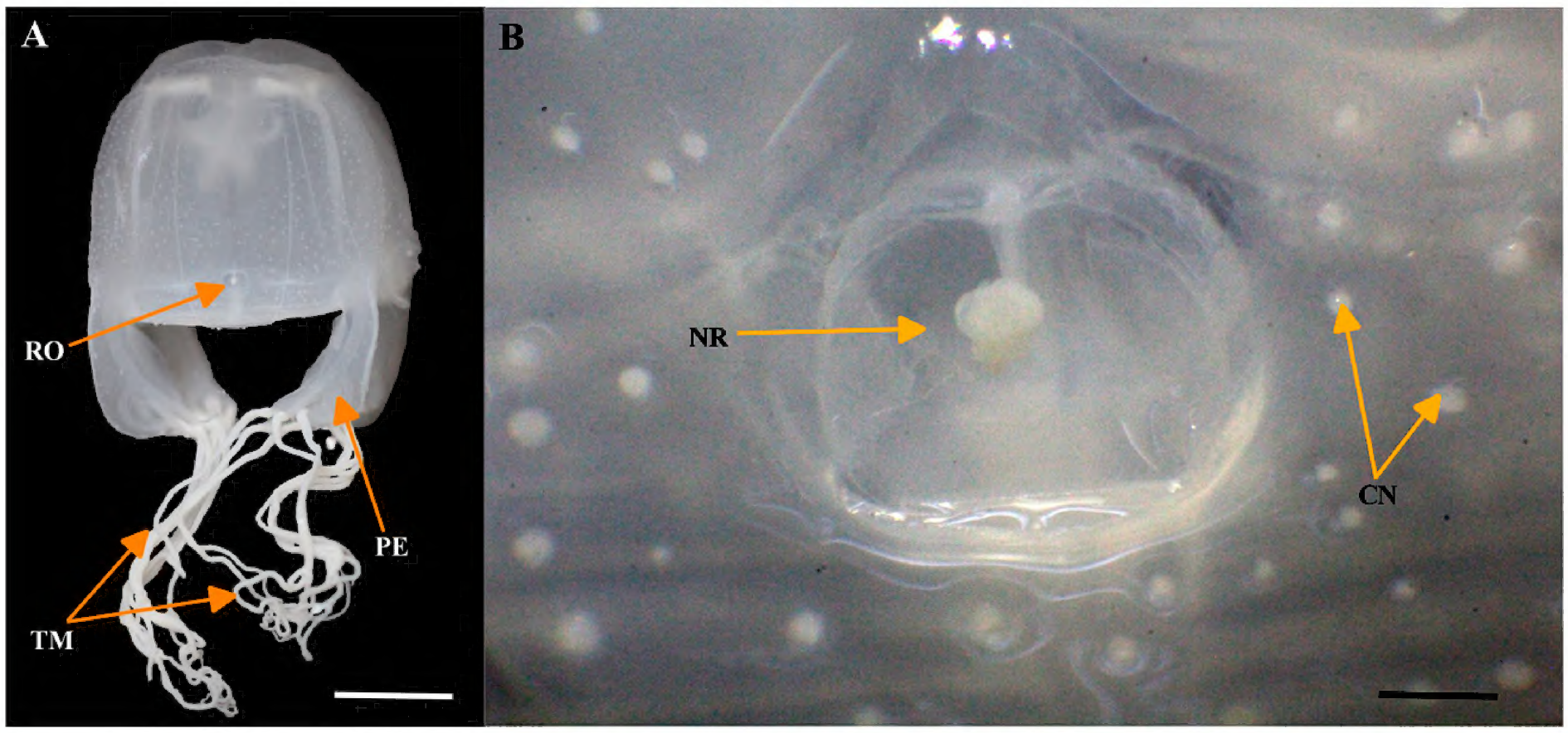

Figure 3. *Chiropsalmus quadrumanus* (Müller, 1859). **A.** Branched pedalia (PE), numerous tentacles (TM), and the rhopalia (RO). **B.** Dome shaped rhopaliar niche ostium (NR) and clusters of nematocysts on the umbrellar surface (CN). Scale bars: A = 16 mm, B = 1.5 mm.

sacs directed in position to the velar channels; 4 paired gonads located in the gastric pouches, usually in form of a butterfly and separated by an interradial septum and attached to septum at center; system of channels connecting the gonads through septum; 4 rhopalia located on each of the walls on exumbrella; frown-shaped rhopaliar niche ostium; spermatophores present.

Tripedalia cystophora was determined using morphological features such as the number of pedalia per side (key and diagnostic for the identification of this species), form of the rhopaliar niche, location and number of rhopalia, and shape and location of the gonads (Bentlage and Lewis 2012). This species is easily recognizable because it differs from other species of Carybdeida by the presence of 3 pedalia on each side. This character might cause confusion with *C. quadrumanus* due to the presence of multiple tentacles; however, *T. cystophora* has a single, branched pedalia per side (Lasley et al. 2016). Our measurements of this species from Dzilam are slightly smaller than measurements of the bell length and width provided by Ekins and Gershwin (2014); this suggests that our specimens were in the early stages of development.

Bentlage and Lewis (2012) noted sexual dimorphism in these species. However, in this case the sex of each of our specimens could not be determined because they were juvenile, or the gonads were damaged by the process of collection and fixation.

***Chiropsalmus quadrumanus* (Müller, 1859)**
Figure 3

Materials examined. Mexico. Yucatan, Chelem (21°07′ N, 089°40′W), Lorena León Deniz leg., 2.0 m depth, November 2016 (2 specimens, YUC-CC-254-11-01542, 01543).

Identification. Observed features of the collected specimens: swimming bell slightly wider than high with a rounded and thickened apex, whitish and translucent; mesoglea rigid; nematocysts clusters present on surface of exumbrella and concentrating these ones moderately on fold of umbrellar edge; leaf form gonads joined along the interradial septum and extending outward from 4 gastric saccules; manubrium with 4 pointed lips; 4 branched pedalia with numerous tentacles; 4 rhopalia with niche dome-shaped located each on the 4 walls of the exumbrella, lacking rhopaliar horns, Velarium broad and with numerous velar channels.

The identification of *C. quadrumanus* was determined by the diagnostic characters of the genus, such as the branching pedalia with the presence of numerous tentacles, the number of gastric saccules, shape of the gonads, shape and location of the rhopaliar niche, and the presence of nematocysts warts on the surface of the umbrella (Gershwin 2006, Cedeño-Posso and Lecompte 2013).

Our comparison of measurements of our specimens with those made by Müller (1859) in the original description of this species shows that our specimens are clearly smaller. They are, however, more similar in size to Gershwin's (2006) specimens. The presence of nematocyst warts in our specimens is characteristic of the genus (Gershwin 2006). Two specimens from Chelem lagoon have 6 tentacles, whilst the other 6 jellyfish had 7 tentacles. Müller (1859) and Gershwin (2006) indicated a range of 7–9 tentacles.

Discussion

The new records of *Chiropsalmus quadrumanus* and *Tripedalia cystophora* from 2 coastal lagoons of Yucatán represent range extensions of these species. These two species are associated with the mangrove forest and estuarine ecosystems (Gershwin 2006, Ekins and Gershwin 2014).

An earlier record of *T. cystophora* was reported in the Gulf of Mexico by Lasley et al. (2016) in the northern Gulf in Florida. Our new record extends this species' distribution to the southern Gulf of Mexico and represents the first time that *T. cystophora* was been reported from Mexican waters. Previous lists of jellyfish species along the coasts of Mexico (Segura-Puertas et al. 2003, Gasca and Loman-Ramos 2014) and in the Gulf of Mexico (Segura-Puertas et al. 2009) did not include this species. Likewise, our new data increases the number of marine invertebrates recorded for the State Reserve of Dzilam from 19 to 20; cnidarians had not been previously recorded from the reserve (Diario Oficial de la Federación 2018).

Our record of *C. quadrumanus* in the lagoon of Chelem is the first for the state of Yucatán. The closest previous record is the lagoon of Términos, Campeche, Mexico (western Yucatan Peninsula) (Gómez-Aguirre 1986). This is a very well-documented species in the Gulf of Mexico, principally in northern Gulf.

From all the cubozoan reported from the Gulf of Mexico, most belong to the order Carybdeida, except *C. quadrumanus* (Lasley et al. 2016). Reports of cubozoan species are mostly in the northern Gulf of Mexico in contrast to the southern Gulf and Mexican waters, which remain little-studied. The few Yucatán records suggest that there is a lack of research on jellyfish in the coastal lagoons of Yucatán.

Lasley et al. (2016) mentioned that many of the recent records of *T. cystophora* around the world are the result of human introductions. However, we cannot conclude here that our new jellyfish records represent introductions. It is probable that these species have always occurred in these lagoons and our new records are only evidence of the lack of previous investigation in this field.

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Authors' Contributions

JMAH and LVLD conceived, designed, and financed this project; ACC and LLR developed the methods and identified the species. All authors wrote, read, commented, and approved the final manuscript.

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